Three New Species of *Biophytum* (Oxalidaceae) from the Venezuelan Guayana

Gerardo Aymard C.
UNELLEZ-Guanare, Programa de R. N. R., Herbario Universitario (PORT), Mesa de Cavacas, Estado Portuguesa 2333, Venezuela. gaymard@cantv.net

Paul E. Berry
Department of Botany, University of Wisconsin–Madison, 132 Birge Hall, 430 Lincoln Drive, Madison, Wisconsin 53706, U.S.A. peberry@wisc.edu

ABSTRACT. *Biophytum kayae*, *B. lourteigiae*, and *B. ottohuberi* from Bolívar and Amazonas states in Venezuela are newly described and illustrated. All are members of section *Dendroidea* Knuth and have sessile or shortly pedunculate inflorescences. *Biophytum ottohuberi* is a distinctive, high-elevation tepui endemic with small leaves and rigidly coriaceous, thick-margined leaflets; *B. lourteigiae* and *B. kayae* are both lowland species on predominantly white-sand substrates. *Biophytum lourteigiae* is a taller shrub than *B. kayae* and has longer, less coriaceous leaves and more pubescent capsules. Too few flowering specimens were available to assess whether any of these species are heterostylous, but the flowers that were examined have their stigmas and two sets of stamens positioned in a way that is consistent with tristyly.

Key words: *Biophytum*, heterostyly, Oxalidaceae, tristyly, Venezuela.

Biophytum DC. is a pantropical genus of about 80 species (Lourteig, 1980) that is distinguished from other genera of Oxalidaceae by its clusters of paripinnately compound leaves at the branch tips. While preparing the Oxalidaceae treatment for the *Flora of the Venezuelan Guayana* (Aymard & Berry, 2003), we found several specimens of *Biophytum* that could not be placed with any known species in the genus. Further examination showed these to be new taxa, and they are described below as new species. All three species of *Biophytum* belong to the large Neotropical section *Dendroidea* (Knuth, 1930), by virtue of their small, elongate- or rectangular-falcate leaflets, often reduced peduncles or pedicels, headlike inflorescences, and numerous bracteoles.

Biophytum is one of only eight genera in three families of flowering plants (Lythraceae, Oxalidaceae, and Pontederiaceae) where trimorphic heterostyly, or tristyly, has been clearly demonstrated (Weller, 1992). In tristylous species, there are three floral forms that differ in the positions of the stigmas and the two sets of anthers; in the short-styled morph, the stigmas occur in the low position and the anthers in the middle and high positions. The mid-style morph has the anthers in the low and high positions, and the long-styled morph has its anthers in the low and middle positions. The presence of tristyly in *Biophytum* is based entirely on observations of a single species, *B. sensitivum* (L.) DC. (Darwin, 1877; Mayura Devi, 1964). Later, Mayura Devi (1966) found a homostyled population of the same species; these plants all had flowers with the same "mid-homostyle" morphology, that is, the styles corresponded to the mid-style position of the tristyled forms, and the stamens corresponded to the middle and high positions. It is not uncommon for tristylous breeding systems to "break down," that is, show changes that result in distyly, homostyly, or the loss of self-incompatibility (Weller, 1992).

In the species described below, the flowers are clustered near the base of the leaf rosette. When dried as herbarium specimens, the leaves often completely cover the inflorescences, and it is usually not possible to examine the flowers or fruits without causing considerable damage to the specimen. Since there were so few specimens of these species available for study, we limited our floral dissections to a single collection of each species. Consequently, we cannot determine with certainty if these species are tristylous, but we can infer from the relative position of anthers and styles in each species which morph they would represent if the species are indeed tristylous.

Biophytum kayae Aymard & P. E. Berry, sp. nov. TYPE: Venezuela. Amazonas: Río Negro, between Neblina base camp and the mouth of Canyon Grande at Puerto Chimo, along Río Mawarinuma, 00°50′N, 66°10′W, 130–200 m, 6–7 July 1984, *G. Davidse & J. Miller 27052* (holotype, VEN; isotypes, MO, P not seen, PORT). Figure 1A–C.

Biophyto lourteigiae affinis, sed inflorescentiis subsessilis, foliis minoribus rhachidibus 4–6 cm longis, foliolis coriaceis supra reticulate nervatis et capsulis glabris, recedit.

Shortly branched subshrub, the stems 30–50 cm tall, 5–8 mm in circumference at thickest point, erect; branches and branchlets glabrous. Leaves 8 to 13 per cluster, 12- to 14-jugate, rachis 4–6 cm long, densely appressed-barbate on young leaves, glabrescent; leaflets sessile, 1–5 × 1–4 mm, obliquely rhomboid, coriaceous, glabrous and with venation evident on the upper surface, the lower surface reticulately veined and papillate, 12- to 16-veined, the base truncate, the apex obliquely and broadly acute, the margins ciliate when young, glabrescent. Peduncle ca. 2 mm long, glabrous; bracteoles ca. 15, lanceolate, 1–2 mm long, glabrous, ciliate at the margins. Flowers examined (from the type collection) consistent with the short-styled floral morph (if tristylous), pedicels ca. 1 mm long; sepals lanceolate, 3–4 mm long, 12- to 14-nerved, glabrous, margins smooth; petals oblong, white, glabrous, ca. 5 mm long; longer stamens ca. 4 mm long, filaments pilose, shorter stamens ca. 2 mm long, filaments glabrous, the anthers ovoid, 0.2–0.3 mm long; ovary 5-lobed, ca. 1 mm long, sparsely appressed-pilose; styles 5, 0.3–0.6 mm long, stigmas capitate. Capsules 5-lobed, ca. 5 mm long, glabrous; carpels 1-seeded; seed ellipsoidal, ca. 2 mm long, glabrous, slightly striate.

Habitat and distribution. *Biophytum kayae* is known from moist forest understories in areas predominated by white-sand substrates in two areas: near the base of Serranía La Neblina close to the Brazilian border, and farther north in the Río Cuao basin, both in Amazonas state, Venezuela. In both areas, the species occurs at elevations between 130 and 200 m.

Biophytum kayae is similar to *B. lourteigiae* in its obliquely rhomboid leaflets, short inflorescence, and overall leaf dimensions. However, it is a consistently smaller shrublet, with smaller leaves that are fewer in number per cluster (8 to 13 vs. 10 to 18 in *B. lourteigiae*), with more coriaceous and reticulate leaflets, sepals with more veins (12–14 vs. 6–8), shorter peduncles (2 mm vs. 2–7 mm), and glabrous capsules.

Paratypes. VENEZUELA. **Amazonas:** Río Cuao, *H. M. Curran 233* (NY); base of Cerro La Neblina, Río Mawarinuma, vicinity of Puerto Chimo, 00°50′N, 66°05′W, 190 m, *A. Gentry & B. Stein 46929A* (MO, PORT, VEN); base camp on Río Mawarinuma, 00°50′N, 66°10′W, 140 m, *R. Liesner & V. Funk 15864* (MO, PORT, VEN), same locality as previous one, *R. Kral 71999* (VEN).

This species is named for Kay Yatskievych, the resourceful and hard-working editor of the *Flora of the Venezuelan Guayana* series over many years. In that flora's treatment of Oxalidaceae (Aymard & Berry, 2003), this species was treated as "*Biophytum* sp. *C.*"

Biophytum lourteigiae Aymard & P. E. Berry, sp. nov. TYPE: Venezuela. Amazonas: alto Río Orinoco, Caño Soromoni, 15 km W of La Esmeralda, 03°08′N, 65°38′W, 140 m, 28 Feb. 1990, *G. Aymard & L. Delgado 8345* (holotype, PORT; isotypes, MO, NY). Figure 2A–D.

Biophyto ferrugineo proxima, sed foliolis 3–6 mm longis, 2–4 mm latis, bracteolis glabris, subulato-lanceolatis, sepalis 3–3.5 mm longis, glabris; petalis 4–5 mm longis et staminibus majoribus ca. 4 mm longis, minoribus ca. 1 mm longis recedit.

Densely branched subshrub 0.5–1.5 m tall, thickest branches 10–12 mm in circumference, erect; branches and branchlets densely appressed-pubescent at the apex, sparsely appressed-pubescent to glabrescent when mature. Leaves 10 to 18 per cluster, 7-to 18-jugate, rachis densely barbate, 4–10 cm long, retrorse bristles present on young stems just below leaf cluster, soon deciduous; leaflets sessile, 3–6 × 2–4 mm, broadly and obliquely rhomboid or subrectangular, chartaceous to subcoriaceous, glabrous on upper surface with venation obscure, papillate and with evident venation on lower surface, veins parallel and 8 to 12 on each side of the midvein, the base truncate, the apex broadly and obliquely acute, margins densely ciliate-barbate when young, glabrescent. Inflorescence subterminal, peduncle 2–7 mm long, sparsely pubescent; bracteoles 8 to 15, subulate-lanceolate, 1–1.5 mm long, lightly pubescent on both sides and ciliate at the margins; pedicels glabrous, ca. 2 mm long. Flowers examined (from the type collection) consistent with the mid-styled floral morph (if tristylous); sepals lanceolate, 3–3.5 mm long, 6- to 8-nerved, sparsely pubescent externally; petals white, obovate, 4–5 mm long, glabrous on both sides, 4- or 5-nerved; longer stamens ca. 4 mm long, filaments pilose, shorter stamens ca. 1 mm long, filaments glabrous, the anthers ovoid, ca. 0.4 mm long; ovary ca. 1 mm long, densely

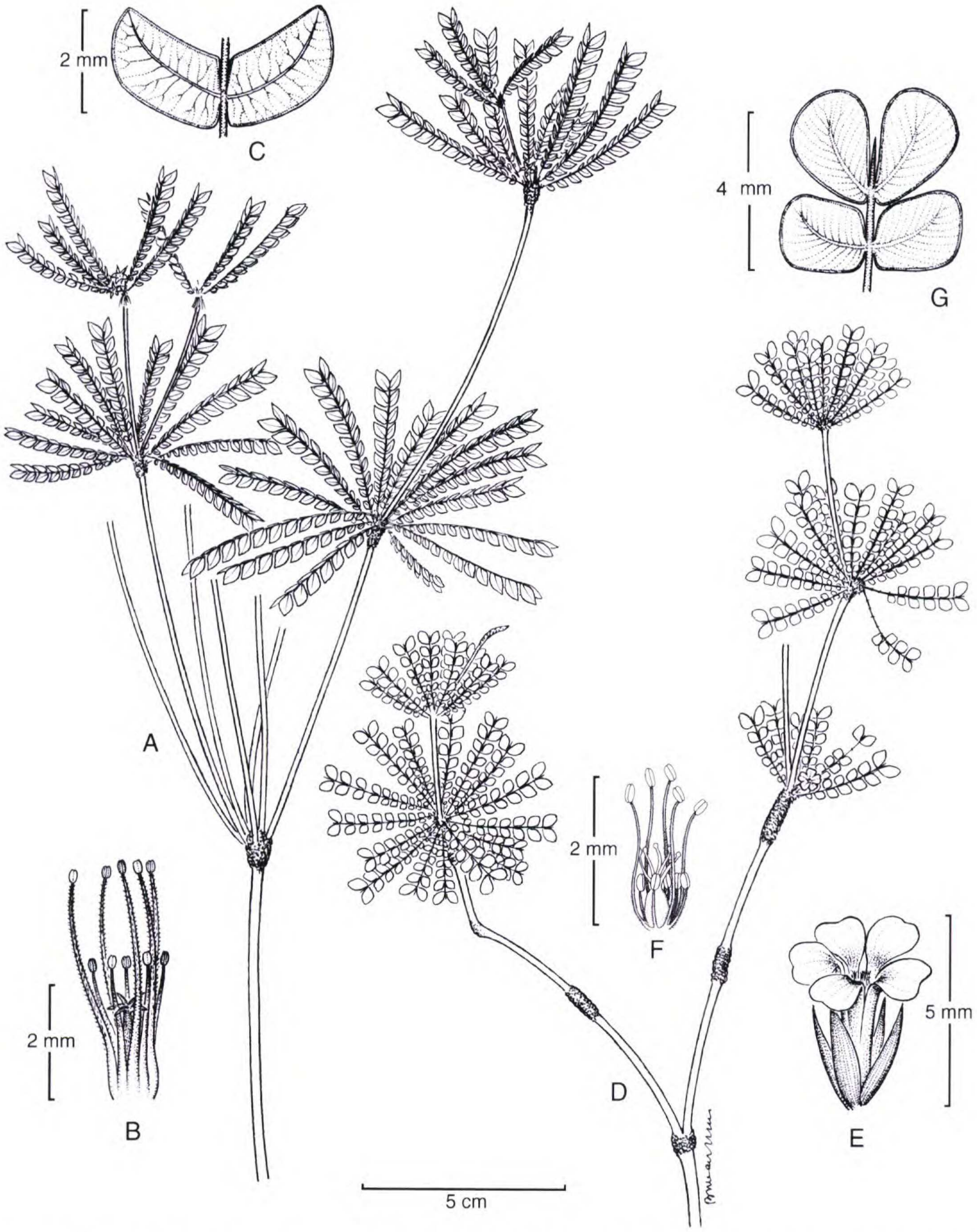

Figure 1. A–C. *Biophytum kayae* Aymard & P. E. Berry. —A. Habit. —B. Flower (short-style form) with sepals and petals removed, showing the short style and two longer whorls of stamens. —C. Pair of leaflets showing the lower surface. Drawn from the holotype, *G. Davidse & J. Miller 27052* (VEN). D–G. *Biophytum ottohuberi* Aymard & P. E. Berry. —D. Habit. —E. Whole flower. —F. Flower (mid-style form) with sepals and petals removed, showing the middle position of the styles between the two whorls of stamens. —G. Distal pairs of leaflets showing the upper surface and the thickened margins. Drawn from the holotype, *O. Huber 10963* (MYF).

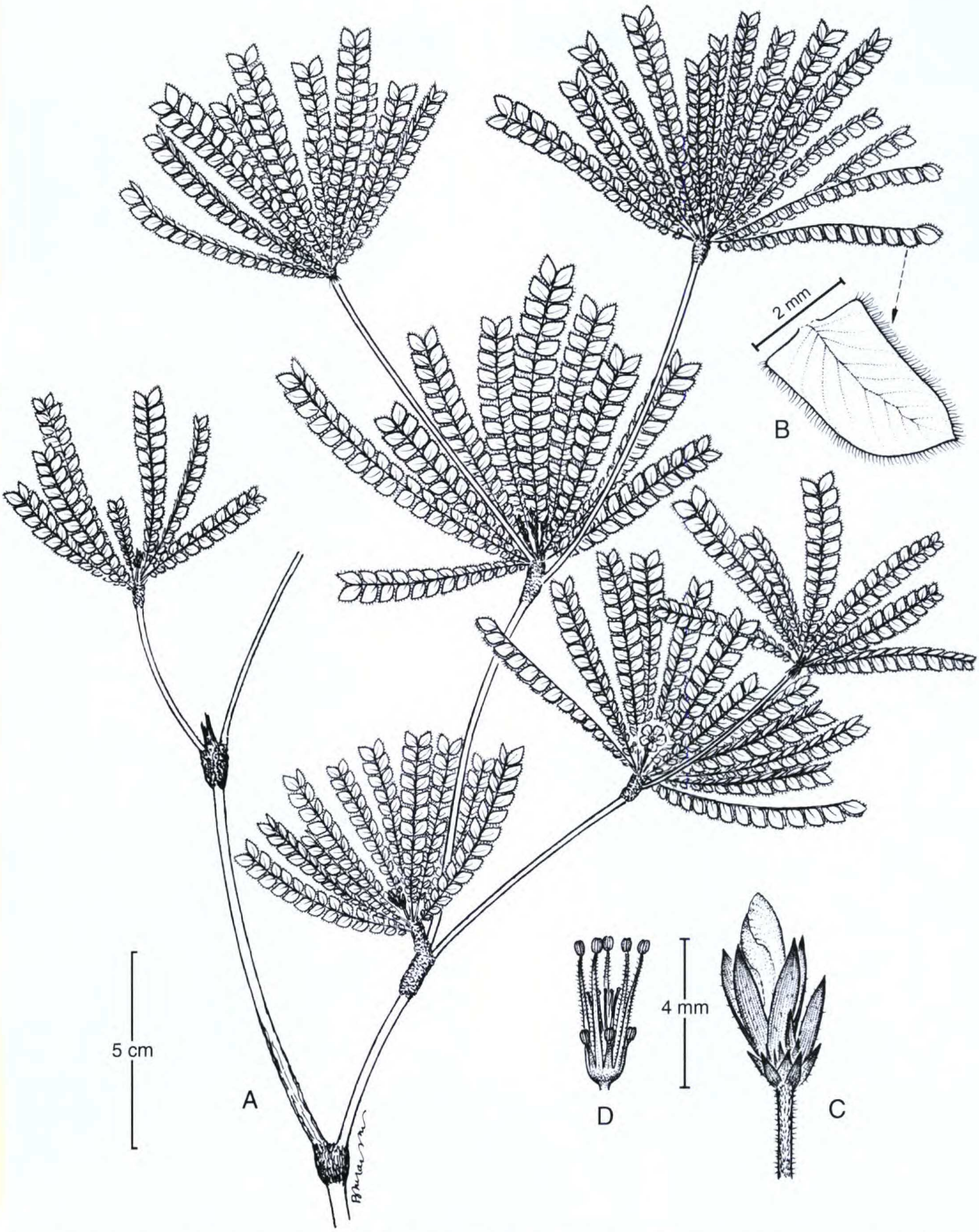

Figure 2. *Biophytum lourteigiae* Aymard & P. E. Berry. —A. Habit. —B. Leaflet showing the lower surface and ciliate margins on young leaves. —C. Flower in bud showing the bracteoles. —D. Flower (mid-style form) with sepals and petals removed, showing the middle position of the styles between the two whorls of stamens. Drawn from the holotype, *G. Aymard & L. Delgado 8345* (PORT).

hispid-pubescent; styles 5, ca. 1 mm long, glabrous, appressed-pubescent at the base; stigmas capitate. Capsules 5-lobed, ca. 3 mm long, glabrous except densely appressed-pubescent at the apex; carpels 1-seeded; seeds ellipsoidal, ca. 2 mm long, glabrous, slightly striate.

Habitat and distribution. *Biophytum lourteigiae*

is known from white-sand areas to the south and west of Cerro Duida, Amazonas state in Venezuela, occurring in the moist understory of evergreen lowland (or occasionally lower montane) forests. Except for one specimen collected at 1000 m elevation (*Liesner 25351*), the rest were found between 140 and 210 m.

Biophytum lourteigiae is morphologically close to *B. ferrugineum* Rusby, from Bolivia, and *B. kayae* from Venezuela. It differs from *B. ferrugineum* in its smaller flowers (sepals sparsely pubescent and 3–3.5 mm long vs. densely pilose and ca. 6 mm long; petals 4–5 mm long vs. ca. 8 mm long), lightly pubescent (vs. ferrugineous) bracteoles, and smaller leaflets (3–6 × 2–4 mm vs. 6–12 × 4–5 mm). Compared to *B. kayae, B. lourteigiae* is a larger plant (to 1.5 m tall), with longer leaves (6–10 × 4–6 cm), more chartaceous (vs. coriaceous) leaflets that have inconspicuous venation on the upper surface, and capsules that are apically densely appressed-pubescent (vs. glabrous).

Paratypes. VENEZUELA. **Amazonas:** Río Cunucunuma, entre las bases de los cerros Duida y Huachamacari, 03°40′N, 65°45′W, 180–210 m, 28–30 Jan. 1982, *J. Steyermark et al. 125838, 126263* (NY, VEN); Río Cunucunuma, Caño Negro, 200 m, *J. Peréz & M. Sosa 28* (TFAV); Culebra, Río Cunucunuma, 03°40′N, 65°45′W, *J. Steyermark & F. Delascio 129140* (TFAV, VEN); Culebra, Río Cunucunuma, 03°44′N, 65°44′W, 210 m, *R. Liesner 17520, 24553* (MO, PORT); Río Negro, afluente del Río Cunucunuma, 03°43′N, 65°39′W, 210 m, *A. Fernández 7649* (MO, PORT), *A. Fernández et al. 8175* (PORT); between Duida and Marahuaca, near base of Cerro Duida, 03°34′N, 65°32′W, 1000 m, *R. Liesner 25351* (MO, PORT).

This species is named in honor of Alicia Lourteig for her extensive taxonomic work on Oxalidaceae. In the *Flora of the Venezuelan Guayana* treatment of Oxalidaceae (Aymard & Berry, 2003), this species was treated as "*Biophytum* sp. *A*."

Biophytum ottohuberi Aymard & P. E. Berry, sp. nov. TYPE: Venezuela. Bolívar: Distrito Cedeño, Serranía Guanay, sector nororiental, cabeceras del Río Parguaza, 05°55′N, 66°23′W, 1700 m, 20–28 Oct. 1985, *O. Huber 10963* (holotype, MYF; isotypes, NY, VEN not seen). Figure 1D–F.

Biophyto dormienti affinis, sed foliolis rigide coriaceis supra glabris, marginibus incrassatis, obovato-obdeltoideis vel late oblongis, 5–9 jugatis, floribus sessilibus, petalis pallide purpureis et ovariis adpresse pilosis recedit.

Shortly branched subshrub, the main stem 30–50 cm tall and 5–8 mm in circumference at thickest point, erect; branches and branchlets densely appressed-pubescent, sparsely pubescent to glabrescent when mature. Leaves 10 to 20 per cluster, 5- to 9-jugate, rachis 2–6 cm long, densely barbate when young, glabrescent; leaflets sessile, 1–4 × 1–3 mm, asymmetric, obovate-obdeltate to broadly oblong, rigid-coriaceous, strongly reticulate and glabrous on upper surface, lower surface papillate and with inconspicuous venation, 18- to 24-veined, the base truncate, the apex broadly rounded, margins thickened, ciliate when young, glabrescent. Inflorescence subterminal, globose, sessile or subsessile, peduncle 0–1 mm long, appressed-pubescent; bracteoles ca. 10, clustered, setaceous, ca. 1 mm long, sparsely pilose on both sides, ciliate at the margins. Flowers examined (from the type collection) consistent with the mid-styled floral morph (if tristylous), sessile; sepals lanceolate, ca. 3 mm long, 8- to 12-nerved, subglabrous, margins glandulose-ciliate; petals pale purple, obovate, ca. 4 mm long, glabrous, 5- to 7-nerved; longer stamens ca. 2 mm long, filaments pilose, the shorter ones ca. 0.5 mm long, filaments glabrous, the anthers ovoid, ca. 0.3 mm long; ovary 5-lobed, 0.8–1 mm long, appressed-pilose; styles 5, pilose, 0.3–0.5 mm long; stigmas capitate. Capsules 5-lobed, ca. 3 mm long, appressed-glandulose to pilose, carpels 1-seeded; seed ellipsoidal, ca. 2 mm long, sparsely ciliate, slightly striate.

Habitat and distribution. *Biophytum ottohuberi* is known only from the type collection, in low forests in sandstone rocky areas around 1700 m elevation on the summit of Cerro Guanay, a tepui near the border of Amazonas and Bolívar states, Venezuela.

In its small leaflets and nearly sessile inflorescence, *Biophytum ottohuberi* is similar to *B. dormiens* (Martius & Zuccarini) Knuth from the Rio Negro area of Amazonas state in Brazil (Zuccarini, 1825; Knuth, 1919). However, *B. ottohuberi* differs from that species in the following ways: its leaflets are obovate-obdeltate to broadly oblong, glabrous on the upper surface, 5- to 9-jugate, and with thickened margins (in *B. dormiens* the leaflets are obliquely rhomboid, appressed-pubescent on the upper surface, less coriaceous, 17- or 18-jugate, and the margins are not thickened). Also, the flowers of *B. ottohuberi* are sessile, with pale purple petals and an appressed-pilose ovary, while in *B. dormiens* the flowers have pedicels 1–2.5 mm long, white petals, and the ovary is glabrous or at most apically pilose.

The species is named after Otto Huber, who collected the type and made many unique and valuable collections from the tepuis of the Venezuelan Guayana. In the *Flora of the Venezuelan Guayana*

treatment of Oxalidaceae (Aymard & Berry, 2003), this species was treated as "*Biophytum* sp. *B.*"

Acknowledgments. We are grateful to Bruno Manara (VEN) for preparing the illustrations, Henk van der Werff (MO) for revising the Latin diagnoses, and the Missouri Botanical Garden and New York Botanical Garden staff for making their research facilities available for our research. We also thank Eve Emshwiller and an anonymous reviewer for their helpful comments to an earlier version of the manuscript.

Literature Cited

Aymard, G. & P. E. Berry. 2003. Oxalidaceae. Pp. 619–625 *in* P. E. Berry, K. Yatskievych & B. K. Holst (editors), Flora of the Venezuelan Guayana, Vol. 7, Myrtaceae–Plumbaginaceae. Missouri Botanical Garden Press, St. Louis.

Darwin, C. 1877. The Different Forms of Flowers on Plants of the Same Species. J. Murray, London.

Knuth, R. 1919. Oxalidaceae americanae novae. Notizbl. Bot. Gart. Berlin 7: 289–318.

———. 1930. Oxalidaceae. Pp. 391–417 *in* A. Engler (editor), Das Pflanzenreich Regni vegetalis conspectus IV (130). Verlag von H. R. Engelmann, Berlin.

Lourteig, A. 1980. Oxalidaceae (Family 84). Flora of Panama. Ann. Missouri Bot. Gard. 67: 826–834.

Mayura Devi, P. 1964. Heterostyly in *Biophytum sensitivum* DC. J. Genet. 59: 41–48.

——— & M. Hashim. 1966. Homostyly in heterostyled *Biophytum sensitivum* DC. J. Genet. 59: 245–249.

Weller, S. G. 1992. Evolutionary modifications of tristylous breeding systems. Pp. 247–272 *in* S. C. H. Barrett (editor), Evolution and Function of Heterostyly. Monogr. Theor. Appl. Genet. 15. Springer-Verlag, Berlin.

Zuccarini, J. G. 1825. Monographie der Amerikanischen *Oxalis*-Arten. I. E. v. Seidel Schriften, München.